LCA and Ecolabelling

Application of Life Cycle Assessment in Environmental Labelling

German Experiences *

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Abstract

The present state of worldwide discussions of how to apply LCA in environmental labelling, taking into account the current ISO 14 020 and ISO 14 024 works, is described. There is a consensus to use LCA as a tool for more scientific environmental labelling. The examples presented verify some practical possibilities to realise this approach. As a background to different stages of practical labelling, results from LCA studies are already used in the German "Blue Angel" scheme, e.g. for the definition of the scope in one product category, for the priorisation of specific life cycle phases and criteria, as a basis to establish a scoring system or to emphasise the importance of information on how to use environmentally sound products. Practical examples are presented in detail for hand-drying systems, paper products, milk packages, household equipment, televisions and detergents. Some future perspectives are mentioned.

Keywords: Detergents; environmental labelling; hand-drying systems; household equipments; ISO 14 020; ISO 14 024; ISO 14 040; Life Cycle Assessment; milk packages; paper products; television

1 Introduction

In current publications, presentations and discussions of Life Cycle Assessment (LCA) principles and guidelines, environmental labelling is considered to be one of its important applications:

- The Draft International Standard ISO/DIS 14 040 [1] mentions the application on ecolabelling in the framework of supporting environmental claims in marketing (assistance of LCA).
- In the current discussions of the Committee Draft ISO/CD 14 024 [2] a "**life cycle consideration**" is required in order to fulfill the objective of reducing environmental impacts and to avoid the transfer of impacts across media or stages of the product life cycle. This standard contains a matrix as an example for realisation.
- The overall ISO/CD 14 020 [3] confirms this life cycle approach. ISO/DIS 14 040 is mentioned as a reference document.
- According to the European eco-label award scheme [8], the specific ecological criteria for each product category "shall be established using a 'cradle-to-grave' approach". In order to give guidance to environmental labelling practitioners, an European group of very well accepted LCA-experts has developed some research recommendations which are published in a guidance document [5].

It has to be underlined that LCA, according to most of these documents, functions as a **tool** for an improved, more transparent and more scientific-based environmental labelling. However, it is also stressed that, "The extent to which the life cycle is considered may vary depending on the type of environmental label or declaration, the nature of the claim and the product category" [3]. The extent of the realisation of this approach therefore depends on each specific product category and on the approach of each environmental labelling scheme. This position is confirmed by recommendations that LCA can never be a substitute for decision-making. "LCA can only be a decision support tool" [4].

From a **practitioner point of view**, there are still a lot of uncertainties addressing the use of LCA in practical labelling. These uncertainties, for example, concern the following points, based on discussions at the sessions of the independent German Environmental Labelling Panel [7]:

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- Fears of too much automation and mechanism in the panel decision processes by LCA-results,
- unsolved methodological problems and therefore too high risks of the manipulation of final decision-making,
- a long-term guarantee by LCA-results for the labelling credibility cannot be given,
- LCA-studies with present data may hinder or negatively influence well-known and accepted principles for a long-term sustainable product design like the promotion of reusable packaging, recycling facilities or the preference for renewable biological resources,
- technical options and innovations, which may be a breakthrough for future developments, and which may require support from labelling activites, may be restricted by LCA because of status-quo scenarios and present data,
- irritations in the public can be foreseen if labelling programs must be changed because of new LCA-results that substitute older LCA-results.

The findings of a report on the use of LCA in environmental labelling programmes [6] underline the general approach of the life cycle concept worldwide, although the practice seemed to be still in its infancy (until 1993). "LCA is being used as a tool to inform the process of developing labelling criteria (...) but it has not taken the place of expert judgment and consensus building in developing these criteria" ([6] No. 4.4). The most interesting use of LCA is for the identification of significant environmental impacts in the various phases of the life cycle in order to guide the development of criteria that mirrors those impacts (No. 4.6). This type of application may be defined as the "**prioritisation**"-function (*see section* 2).

2 Practical Use of LCA in Environmental Labelling

On the basis of the proposals made by the scientific community and experiences gained by labelling practitioners, the **following functions** can be identified:

- **Prioritisation of product categories:** LCA may provide practitioners with an orientation concerned with the importance of product categories according to the result of the "normalisation" step in an impact assessment.
- **Scope definition of product-sytems:** Results from LCA-studies help practitioners to define the scope of a product category. These results provide the schemes with a scientific basis for the inclusion or exclusion of competing different product types (*see case studies 3.2, 3.4*), of different competing materials for making the same product (see *case study* 3.3) and also of different competing processes to produce the same product. There is no doubt that this function is the **most controversial use** as far as claims of overall environmental superiority and comparative assertions are concerned [1].
- **Functional unit:** The definition of the functional unit in LCA may guide practitioners to suggest a suitable basis for the criteria *(see case study 3.2)*.
- **Prioritisation of life cycle phases:** This function addresses the identification of the most important phases in the life cycle of a product system. The criteria development process should take these results into account in order to obtain the most important potential of improvements (*see case study 3.5* and also a part of *3.4*).
- **Prioritisation of specific criteria:** This function addresses the prioritisation of specific environmental impacts in terms of inventory data in a product's life cycle as a basis for the choice of the type of criteria, the definition and the establishment in terms of so called hurdle criteria (*see case study 3.6*) [5].
- **Establishment of scoring systems:** LCA results, e.g. obtained from the inventory analysis, may be used to establish a scientific, quantitative weighting procedure for the content of chemical substances in products or for scores addressing specific environmental impacts in a product life cycle. First experiences in that field are won in the European Ecolabel for detergents [14] and several paper products [11] (*see case studies 3.3* and *3.7*).
- **Function to check the completeness of important critera:** Life cycle inventories of product systems may additionally be used to check the completeness of the selected and drafted criteria. The "Blue Angel" standard for computers which is considered worldwide is an example of that application [9].
- **Importance of consumer behaviour/information/education:** Practitioners must assess the share of influence of consumer behaviour to the overall environmental impacts in a product category. Requirements which address duties for a broad consumer information may be established as a conclusion if LCA studies show significant influences (*see case study 3.7*).

There are some more ideas how to use LCA for environmental labelling, e.g. the development of criteria based on impact categories (according to the classification and characterisation) [5], practical experiences are not yet available from the German scheme.

3 Examples of Use

The German Environmental Labelling Scheme ("Blue Angel") was created in 1977 by the German federal ministry of the interior. Germany was the first country to implement a national eco-labelling programme for products. This scheme served as a model for the efforts of many other countries [26]. At the end of 1996, 920 companies had been awarded the "Blue Angel" for 4,100 products in 76 different product-categories. Until today, it is the most developed environmental labelling scheme.

Detailed information of the German "Blue Angel" scheme can be acquired from the Federal Environmental Agency (see address and fax no. above, home page: http://www.blauer-engel.de).

3.1 Priorisation of product categories

The normalisation step in Life Cycle Impact Assessment stage includes the relation of impact scores from one product line to the actual magnitude of some specific impacts in a given area. This may create a better basis for a further valuation step [22].

Such an analysis offers environmental labelling practitioners more guidance to select product categories with a real importance for the overall environmental impacts. Considering the present list of product categories in the European Ecolabel Scheme, it may be allowed to suppose that this application has not yet been used continuously. Product categories with an assumed relatively higher proportion of impact scores like detergents, paper products or refrigerators are persued as well as product categories with an assumed lower proportion like rubbish bags, shampoos or hairsprays.

The product category "**television**" may be mentioned as an example of a higher prioritisation. For this product category, it may be possible to accept energy parameters as key indicators (*see case study 3.6*). 40.6 million German televisions consume 6,750 GWh. This means 1.2% of the total electricity consumption or 5.5% of the total household electricity consumption [23].

The example of a lower prioritisation is the product category "**packaging**". In the case of packages for fresh milk only a 0.01% proportion for CO2 of the entire CO2-emission in Germany was calculated [15].

Another estimation concerns the share of "**washing processes**" in terms of energy, which was estimated as being 1.3% of the total German energy consumption (185 PJ). The distribution underlines the dominance of the use phase (55% by washing machines and 23% by washing dryers) compared with the production phase (22% by production of machines and detergents). 11.8% is concerned with the share of the fresh water consumption. The probably higher proportion of the waste water impact caused by detergents was not examined [18].

There are some similarities in the use of normalisation techniques for prioritising single impacts and criteria setting which is described below (*see 3.4, 3.5* and *3.6*).

3.2 Hand-drying systems

One of the most controversial themes in environmentally-related public purchasing debates is the question, of whether there is an overall ecological superiority of one particular hand-drying system. Environmental aspects are used in advertising to claim environmental superiority by the competitors. The "Blue Angel" scheme had to learn that the first orientation, to include only towels made of recycled paper (instead of virgin paper), was misunderstood by purchasers and had some discriminatory effects on the non-paper systems.

Already existing and available LCA-studies concerning hand-drying systems were analysed by the Federal Environmental Agency [10].The main findings are summarized in **Table 1**. The **functional unit** was definded with "**one use**" (one cotton or paper towel, 30 s operational time for an electric dryer). The wide range of impact data can be explained by differences in the technology used by the different companies and with the data used in the LCA-studies.

Table 1: Results of LCA studies for hand-drying systems (Source: Federal Environmental Agency [10])

Environmental Aspects	Electric Dryer	Towel/Virgin Paper	Towel/Recycled Paper	Cotton Towel
Energy Consumption	0.016 - 0.03 kwh	0.017 - 0.04 kWh	0.007-0.019 kWh	0.014-0.015 kWh
Water Consumption	-	> 1.0 l	0.04 - 0.3 l	> 0.1 l
Waste	-	3 - 5 g	3 - 5 g	0.1 - 0.2 g
Raw Materials	not renewable resources	renewable resources	secondary resources	renewable resources
Waste Water	-	50 - 1.700 mg COD	10 - 15 mg COD	50 - 120 mg COD
Air Emissions - CO_2 - SO_2 - NO_x	 13 g 19 - 34 mg 26 - 43 mg	 33 g 10 - 17 mg 10 - 90 mg	 12 g 1 - 6 mg 10 - 30 mg	 2 g 13 - 20 mg 30 - 40 mg
Transport (indicator for noise)	marginal	from time to time	from time to time	additional transports

The three main findings of this analysis were:

- Because of unsolved weighting problems among impact categories, no overall superiority of one system can be ascertained.
- Towels made of virgin fibres are the worst system from an environmental point of view.
- The LCA-studies identified several improvement possibilities which were used as a basis for developing ambitious criteria for environmental labelling.

It was argued that a new LCA study would not lead to other results as the findings are concerned. The German "Environmental Label Panel" has now decided – after a very long discussion – to establish environmental label criteria for

- recycled paper towels (RAL-UZ 5): the most important criterion addresses the use of low and medium-grade waste paper,
- cotton towels in dispensers (RAL-UZ 77): the most important criteria address the substitution of ecotoxicological substances in detergents and the avoidance of chlorine in washing,
- electric dryers (RAL-UZ 87): the most important criteria address a low electrical consumption (<0.017 kWh for one use – 30 s), an automatic on/off-function and a take-back duty.

3.3 Paper products

The promotion of recycled paper products in Germany has a long history and belongs to the most discussed environmental action by public purchasing. As a result of the nearly 20-year old promotion, recycled paper products can now be bought in most shops. For private consumers, these products may have reached a market share of 20-30%. Recycled paper products have also become a very important theme in environmental purchasing, in governmental institutions as well as in private companies and institutions. The market share in the sector "office paper" has continously grown in the past and has now reached a share of 40-50%.

One reason for these positive effects may be the high public attention and aquaintance for this theme influenced by the "Blue Angel". The definition of the product category ("scope definition" in Environmental Labelling) including only recycled paper in the field of paper products was one of the most important early decisions of the "Environmental Label Panel", which is still valid today.

During the preparation of an European Ecolabel, which addresses mainly the production phase of paper products [11], this "German position" to exclude virgin fibres was criticised several times for not being in line with present results from LCA-studies. Thus, the Federal Environmental Agency analysed the results of available studies from the 80ies [12].

The conclusion of this analysis was the confirmation of an overall environmental superiority for recycled paper products.

This position was confirmed by another study. On the basis of a scoring system worked out for the European Ecolabel [11], the branch wide data relating to ten different technical processses to produce paper was analysed. This study underlined a continious significance to valuate an environmental superiority for the production of recycled paper [13].

The present developments of the German recycled paper labelling inside the "Blue Angel" address points of improvements in this product line [21]:

- High share of low grade and medium-grade waste paper,
- hurdles for the content of some hazardous substances, e.g. minimised thresholds for formaldehyde and PCB,
- various azo dyes which may split some defined amines are excluded.

In order to provide not only the future environmental labelling discussion but also the waste management policy for paper with results from modern LCA methodology and reviewed data from modern paper technology, a new ambitious LCA-project under commission of the German Federal Environmental Agency was performed [16]. The goal definition includes the comparison of paper products (vir-

Table 2: Results of selected LCA projects for paper products (Source: Federal Environmental Agency, available studies 1984-1991 [12])

	Virgin Paper (Pulp)	Wood Pulp	Recycled Paper
Consumption of Wood (kg wood/t paper)	1,666 - 2,435	1,020 - 1,111	1,100 (only waste paper)
Consumption of Energy (GJ/t paper)	34.6 - 53.4	29.1 - 36.8	13.0 - 16.8
Consumption of water (m^3/t paper)	20 - 400	5 - 30	5 - 16.5
Waste Water			
COD (kg/t paper)	20 - 290	2,7 - 90	0.8 - 5
AOX (kg/t paper)	0 - 10	< 0.02	0.012 - 0.2

gin/recycled paper for newspapers, magazins and copying paper) as well as waste paper treatment options (material recycling or thermic use in incinerators). Results are expected in 1998.

3.4 Packages for fresh milk

The German "Life Cycle Assessment of Drink Packaging Systems" [15] is one of the most sophisticated LCA-projects worldwide. Without doubt, it is the most discussed in Germany. The main goal of the study was to determine which of the investigated packaging systems causes the lowest environmental impact. Included were cardboard packages, returnable glass bottles and polyethylene bags in the fresh milk case-study, and returnable and non-returnable glass bottles, tinplate cans and aluminium cans in the beer case-study. Polycarbonate was not included. The results will be used for further "public policy making" (ISO/DIS 14 040) in the packaging field, which has a high priority in the overall German environmental policy. The ambitious methodological assumptions and discussions on this project cannot be described here in their entirety.

The findings of this LCA do not confirm the present environmental labelling line in all points. According to the assumed conditions, the returnable bottle system is clearly environmentally superior to all non-returnable systems in the case of beer. In the case of fresh milk, it has been found that the returnable system is environmentally superior to the cardboard packagings, although not to a significance comparable with beer. The polyethylene bag should be considered to be environmentally friendly as a returnable system (→ *Fig. 1*). In some alternative scenarios, the PE bag was even superior.

The Environmental Label Panel has begun the discussion to include the PE bag in the labelling of returnable bottles for milk which are offered in most supermarkets. This discussion has not yet come to an end because of another very important result of this LCA study for environmental labelling. The influence of the **transport distance** as an important life-cycle phase was underestimated. It can be shown, for instance, that the transport distance highly influences the overall results of some very important environmental impacts like global warming, acidification, photo-oxidants, etc. Under the assumptions of a 100 km transport distance, approximately 75% of NOx-emission of returnable milk-bottles are caused by the transport, although only the packaging weight was included. It may be claimed that the inclusion of the beverage weight would dramatically increase the importance of transport and emphasise transport reduction as the highest potential to improve the environmental performance of beverages.

One conclusion for further criteria development in this field is that transport distances have to be included in the criteria itself, e.g. as a distance limitation for the milk purchasing by the dairies and the distribution to the retailers for the packed beverages. The dairies may be able to fulfill such requirements. A feasibility study to gain more clarification in that field has brought interesting results which are now discussed with the parties interested. The administrative expenditures to secure seperate distribution inside and outside a defined region such as a circle, for example, was underestimated. Small and medium sized dairies which provide regional markets support this approach. This discussion finds high attention in the Environmental Label Panel and in the German public as well because of the present discussion to support the regional economics as an important contribution for sustainable development.

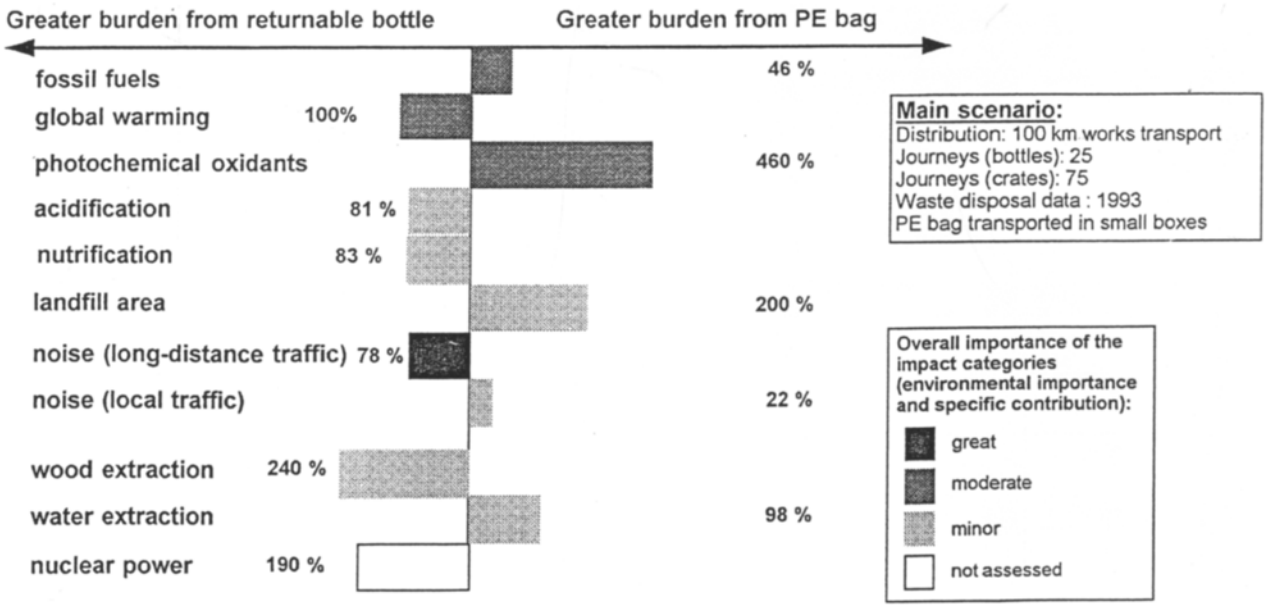

Fig. 1: Packaging systems for fresh milk: comparison between PE bag and returnable glass bottle (Source: Federal Environmental Agency [15])

3.5 Household equipment

Environmental labelling in Germany is discussed continually in terms of product-labelling. Therefore, the consideration of the product and the requirements, which are possible to check in the product, stand in the foreground. There are several difficulties and operational problems to include the production phase in environmental labelling and to transform impacts derived from the production phase to verifyable labelling criteria [24]. Nevertheless, the ongoing discussion, e.g. in the WTO and in ISO about this issue must be continued, e.g. in terms of a distinction between non-product-related and product-related PPM (production and process methods).

According to current LCA results, the importance of the share of the production phase in the overall environmental impacts in the life cycle of a lot of product categories is often overestimated. This will be verified by the distribution of environmental impacts for household equipment in the case of dishwashers and washing-machines [19].

Because of a lot of similarities, it should be allowed to conclude that the same results would be obtained by LCA-studies for other household equipment, consumer electronics (*see 3.6*), cars or for chemical products like paints and detergents which cause significant environmental impacts during their use phase. Some of these studies, especially for motor vehicles, already exist [20].

These LCA results confirm the principle to **focus on the use-stage of products** in the framework of environmental labelling as it is accepted in the German discussion. The reduction of environmental impacts in the production phase, where criteria cannot be checked in the product, should be an important field for environmental regulations or other policy instruments. Nevertheless, there are some sensible fields which have to be handled very carefully and in which easy solutions are not yet available, e.g. the use of pesticides which may be found in the product or not. In the case of cotton, it is possible to wash residual pesticide contents out.

3.6 Television

Based on current discussions, the most important environmental aspect in the improvement of televisions may be seen in the recyclability, the substitution of hazardous flame retardants, the energy consumption and the material optimisation. Enormous efforts are already prepared or even implemented by the industry to improve the recyclability.

A new LCA-study shows the outstanding dominance of energy impacts in the use phase which was not expected in this significance [17]. Energy-related impacts are compared in different life cycle stages. In the context of impact prioritisation in environmental labelling, it may be accepted that this LCA-study only performs energy data.

The ecological optimisation of a TV mainly addresses the energy consumption during the phase of use (→ *Fig. 2, see p. 247*). This was assessed on the basis of generally accepted assumptions like a durability of 12 years and a German average watching time of three hours a day including the use of the stand-by-mode. The use of TV has a share of 5.5% of the total household electricity consumption [17]. One third of this demand is caused by the stand-by-mode alone.

The most important improvement actions were identified for the stand-by-mode. A reduction for the average stand-by power of 7 W to 1 W is possible. Also, further innovations to a 0.1 W reduction were described. 42% of households use the stand-by mode. This energy consumption of 2,150 GWh is comparable with a power plant of 130 MW.

The draft for the environmental label criteria, which is in its final stage, focussed on these results. Issues for a better recyclability and the avoidance of hazardous substances are included. Another conclusion of this LCA-study addresses efforts to increase environmental education and behaviour (*see case study 3.7*). People should not use the stand-by-mode, a suggestion which is so easy to understand, so significant in effects and so difficult to realize.

3.7 Importance of consumer behaviour/information/education

In the framework of a recently published LCA-study on detergents and washing behaviour [18] different average detergent-types were analysed according to the scoring system of the European Ecolabelling criteria. Higher values suggest a better eco-profile [14].

Table 3: Assessment of different average detergent-types (Source: Öko-Institut (on behalf of the Federal Environmental Agency, Berlin 1996 [18])

Detergent-Types	Points EU-Ecolabel Detergents (Hurdle >63)
Conventional Type	39
Compact Type	63
Color-Compact Type	65
Tandem-System (washing/bleaching components)	66
Component-System (separate softener/washing/bleaching components)	72

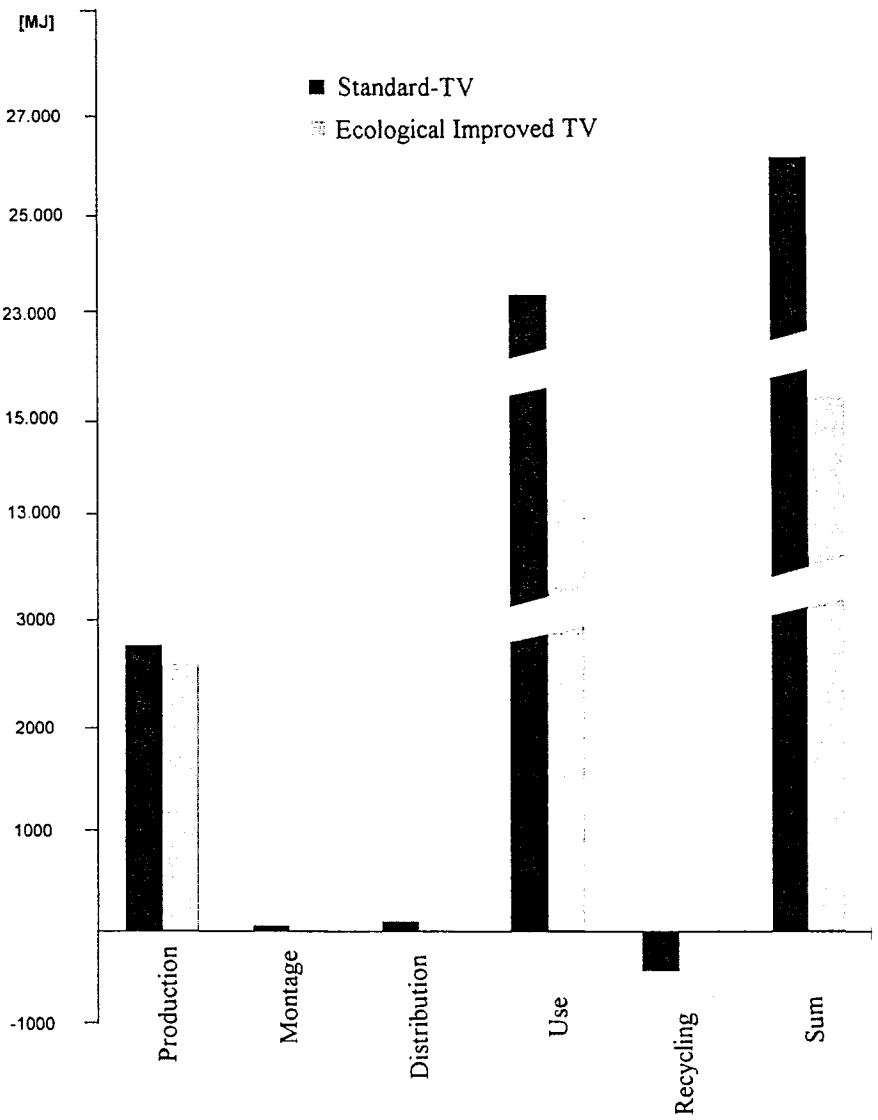

Fig. 2: Energy Consumption of a Standard-TV and an Ecological Improved TV in different Life-Cycle-Phases (Source: Institute for Future Studies and Technology Assessment, Berlin [17])

The first already drawn conclusion of these results was a complete review of the "Blue Angel" criteria for detergents. An overall environmental superiority for only one system, e.g. the component system, was not confirmed in terms of the principle of significance. The scope was redefined in order to include all detergent types on the basis of 63 points as a hurdle. The previous document included only the component systems [25].

High attention has to be given to a second essential finding of this study, also beyond environmental labelling applications. The range of environmental impacts caused by different practices of well-known recommendations in consumer information campaigns on how to wash environmentally sound, were assumed to be:

- full loading
- dosage according to extent of dirtiness
- dosage according to water hardness
- 40°/60° instead of 90°C wash programme
- appropriate frequency of washing
- no prewash programme
- no separate laundry dryer

The difference to practice these recommendations (or not) were defined for three typical households. The results, documented in excerpts in the following table, show dramatic differences. The detergent amount per wash may be accepted as the reference indicator for all damaging water

Table 4: Ecological influences of consumer washing practices (Source: Öko-Institut (on behalf of Federal Environmental Agency, Berlin 1996 [18])

	Eco Household	Average Household	White Collar Household
Laundry amount p.a.	375 kg	500 kg	500 kg
Detergent: Dosage/wash Amount/year	72.3 g 6.8 kg	103 g 18.7 kg	175.1 g 50 kg
Energy	717 MJ	3,140 MJ	8,179 MJ
CO_2-emissions	39 kg	160 kg	449 kg

impacts because water damage effects were not assessed. The especially high energy and CO_2 impacts by the "white-collar household" is caused by the assumed use of a separate laundry dryer.

The conclusions stress future environmental labelling activities of detergents as well as future improvement by the industry itself:

- Priorities for further ecological improvements of the environmental performance of detergents must be given to consumer information and education instead of an ambigious continuous product improvement, e.g. by an additional improved biodegradability of detergent components. This also addresses the allocation of the available budgets for future product improvement.
- The challenge especially for the industrial companies is to study and to discover conditions to change consumer behaviour in optimizing consumer information on how to wash environmentally sound.
- The future review of environmental labelling criteria programmes shall include improved and optimized consumer information and tools on how to wash environmentally sound.

3.8 Future applications

In the framework of the current environmental labelling discussion in Germany, some more interesting points were identified in which the LCA-study may provide the scheme:

- To assess the ecological preference to support the use of renewable resources, e.g. in building products or rape oil in lubricants, if any (scope definition for environmental labelling),
- to assess the ecological preference to support the use of secondary and recycled materials, e.g. in building products, plastic products (to consider are the primary and the waste treatment process), if any (prioritisation of product-categories),
- to assess the inclusion of recycled PVC-products, e.g. window frames and floors, in the scope of products from recycled plastics or to assess an ecological superiority in the case of window frames,
- to win an orientation, if the further step-by-step reduction of emission hurdles for heaters should be implemented because more and more electricity is needed to reach this effect,
- for the scoping of the product category "batteries" (inclusion or exclusion of one way batteries in addition to rechargeable batteries),
- to evaluate the inclusion of newly improved heating technologies.

New projects to establish scoring systems for specific product categories are not functional yet.

4 Conclusions

The examples presented have illustrated some practices how to apply LCA in environmental labelling. It was also described that LCA results cannot be transformed by themselves into labelling criteria, but have to be discussed by practitioners and competent bodies as other findings from science. This work is still in the beginning stage. More exchange of world-wide information is necessary to communicate, which projects are under work, which experiences have been made and what has been learned and decided [27]. LCA results will also contribute to reflect new aspects in environmental labelling, e.g. the consideration of transport distances.

The future vision is to establish LCA application in "good environmental labelling practices" as a scientific and very well accepted tool in order to improve the selection of product categories, the development of criteria and, especially, to meet the environmental priorities.Environmental labelling should be influenced by the environmental targets to reduce environmental damages caused by products. LCA, however, shall give only guidance to environmental labelling bodies but shall not replace the final conclusions which have to been decided by independent panels with a high participation of representatives from non-governmental organisations and from the economic sector.

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[22] SETAC: Guidelines for Life Cycle Assessment, "A Code of Practice" 1993

[23] Pressemitteilung der GSF Forschungszentrum für Umwelt und Gesundheit, München 1996

[24] The author prepares a specific information sheet to illustrate these problems especially for non-pracitioners in the environmental labelling field *(will be sent on request)*

[25] German Environmental Labelling Criteria for Detergents (RAL UZ 70). The reviewed version was published in July 1996

[26] OECD: Eco-Labelling: Actual Effects of Selected Programmes. Paris 1997 (OECD/GD(97)105)

[27] This information exchange may be organised in future by the Global Environmental Labelling Network (GEN). The most important schemes are already to be found in GEN. GEN Home Page Address: http://www.interchg.ubc.ca/ecolabel/gen.html